Performance of Sugarcane Varieties in a White Leaf Disease (WLD)-Prone Environment at Pelwatte

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ABSTRACT

This experiment was conducted to evaluate yield performance and White Leaf Disease (WLD) reaction of fifty commercial and near-commercial sugarcane varieties grown in a field with severe WLD incidence at Pelwatte. The tested varieties were planted in every alternate row of a heavily-WLD-infected field of first ratoon crop established with variety SL 96 128 using completely randomized design (CRD) with three replicates. Varieties Co 775 and SL 83 06 were used as standards to compare yield performance of the varieties and Co 775 was used as the susceptible standard for WLD. Yield parameters of plant crop of the varieties were measured at harvest. WLD incidences were recorded in plant crop up to six months in monthly intervals and continued in ratoon 1 crop up to four months in two months intervals. The WLD insect vector population was assessed in the field in monthly intervals up to six months in plant crop. The results revealed that cane yields of the varieties SL 96 128, SL 98 2118, SL 98 2524, SL 98 2549 and SL 99 3301 were significantly-higher ($P < 0.05$) than the commercial standard Co 775. Sugar yields were significantly-higher ($P < 0.05$) in varieties SL 96 128 and SL 99 3301 compared to Co 775. No significant differences were observed in cane yields and sugar yields of the test varieties compared to SL 83 06. Although, WLD incidences were at very low level (0.0 - 6.2%) in plant crop, noticeable increase of WLD incidences was observed in ratoon 1 crop. Among the tested varieties SL 86 13 and SL 99 3384 were identified as suitable varieties for cultivation in WLD-prone environments due to their low (< 5%) incidences of WLD. The varieties SL 89 309, SL 92 5588 and SL 95 4225 were also identified for cultivation in areas with high WLD incidences, because they have recorded significantly low ($P < 0.05$) percentages of WLD (Less than 16%) in both 2 and 4 months aged ratoon crops compared to Co 775. In addition, adoption of proper crop management practices is suggested to manage the disease in new-improved varieties since gradual build-up of the disease was observed in this study.

Key words: *Sugarcane, varietal performance, White Leaf Disease, WLD resistance, yield parameters*

INTRODUCTION

The Sugarcane Research Institute (SRI) has recommended and released 30 sugarcane varieties for commercial cultivation so far. However, the varietal spectrum of the sugarcane plantations in Sri Lanka is limited to a few varieties indicating low adoption of new-improved varieties by farming communities. As such, popularisation of new-improved sugarcane varieties among farmers has been identified as an important area in increasing productivity and profitability of cane-sugar industry of Sri Lanka (Perera *et al*., 2009; Keerthipala, 2016).

Getaneh *et al*. (2016) reported that the acceptance of a sugarcane variety by the farmers depends very much on its ratooning potential. However, emergence of severe white leaf disease (WLD) incidences in ratoon crops reduces the ratoon yields in sugarcane and it has made a negative impact on popularisation of new varieties which have been developed using considerable amount of money and resources. Hanboonsong *et al*. (2002) and Chanchala *et al*. (2014) stated that WLD is one of the most destructive diseases of sugarcane. Therefore, proper understanding of this disease in commercial plantations and performance of different varieties under such situations are of prime importance in popularisation of new-improved sugarcane varieties among farming communities and sugar industries. Lobell *et al.* (2011) reported that sugarcane varietal performances in terms of reaction to diseases and cane and sugar yields are influenced by the environment.

Conventionally, planting material for commercial sugarcane cultivation is produced through 3-tier nursery system involved with hot water treatment of seed cane (Rathnayake *et al*., 2013). However, the insufficient amount of seed cane produced through this system compels the industries and farmers to obtain seed cane from commercial cane fields resulting spread and build-up of systemic sugarcane diseases. Perera *et al*. (2011) reported that sugarcane plantations in Sri Lanka have been infected with WLD and it reaches epidemic levels time to time. Recommendations for management of this disease include use of healthy seed cane, rogueing-out of diseased plants, control of WLD-transmitting insect vector; *Deltocephalus menoni* and field sanitation.

Keerthipala (2016) described that poor adoption of pest and diseases management practices in local sugarcane plantations is one of the courses for low cane yields and it affects acutely in real performance of new-improved varieties under such environments. Currently, no sugarcane variety is identified with complete resistance to WLD in Sri Lanka in spite of several varieties with tolerance to WLD have been earmarked in ongoing germplasm screening experiments for varietal reaction to WLD. This revealed that different varieties express different levels of WLD symptoms under more or less similar inoculum densities of phytoplasma.

In this scenario, identification of sugarcane varieties that possess better agronomic attributes and resistance or tolerant to WLD is of paramount importance in order to recommend them for commercial cultivation, especially under WLD-prone environments. The “Breeder’s Seed Garden” of the Sugarcane Research Institute comprise all commercial and near-commercial varieties that were found superior in almost all agronomic attributes selected from number of breeding series. As such, the breeder’s seed stock is the best candidate varietal pool with immediate potential to be tested for their performance in WLD-prone areas.

This experiment was conducted to evaluate fifty sugarcane varieties of the breeder’s seed stock for their cane- and sugar-yielding abilities and WLD reactions in a heavy WLD infected field in the Lanka Sugar Company (Private) Limited - Pelwatte with the objective of finding most suitable varieties for commercial cultivation in WLD-prone sugarcane growing areas.

MATERIALS AND METHODS

Location, varieties and the experiment

This experiment was established in field number 70 in the section 1 of Nuclear estate of Lanka Sugar Company (Private) Limited - Pelwatte in November 2016. This area belongs to agro- ecological zone DL_1 and the geographic coordinates of the experimental site are 6^0 711' N 81^0 215' E. A field of first ratoon crop of the variety SL 96 128 that was just after ratooning and severely-infected with WLD was selected for establishment of this field experiment. Stubble in every alternate furrow was removed for planting test varieties in between WLD-infected furrows to facilitate natural infection of the disease. Five-meter-long plots were used to plant test varieties while giving a half-meter space between two plots in the furrows. The furrow spacing of 1.2 m was maintained throughout the experiment. Nine-month-old breeder's seed-cane of fifty sugarcane varieties (Table 1) that were free from WLD symptoms was used for establishment of this field trial. The varieties were randomly-assigned into the plots and each plot was planted with twenty-five 3-budded setts. The experiment followed completely randomized design (CRD) with three replicates. The varieties Co 775 and SL 83 06 were used as the standards to compare yield parameters and Co 775 was used as the standard for comparing WLD incidences. The entire field was irrigated for one-and-half-month period from planting to establish the crop and then it was maintained under rain-fed conditions for the remaining period. Standard cultural practices were adopted to maintain the crop of this experiment.

Number of WLD-infected plants was recorded in each test plots from 3 months after planting to six months after planting in monthly intervals and in ratoon 1 crop the same was recorded from 2 months after ratooning to 4 months after ratooning. WLD vector (*Deltocephalus menoni*) population in the field was recorded as number of vectors per 1000 sweep-nets of 35 cm diameter, simultaneously to the recording of WLD infection.

The crop of this experiment was harvested at 12 months of age and numbers of millable canes per plot and cane weights of the plots were recorded. Rind hardness, stalk diameter, stalk length and number of internodes per stalk were recorded from 12 randomly-selected stalks from each test plot at harvest. These samples were used to analyse brix, pol and fibre values. Purity and pure obtainable cane sugar (POCS) were estimated using brix, pol and fibre values and sugar yield of each test variety was calculated using POCS and cane weight of the plots. The crop of the entire field was ratooned and ratoon 1 crop was maintained further up to 4 months for recording WLD incidences.

Analysis of data

ANOVA and Dunnett's mean separation procedure were used to arrive at inferences on cane and sugar yields and their components of the varieties tested. The varieties Co 775 and SL 83 06 were used as standards to compare yield performances. Disease incidences were analysed by fitting Generalized Linear Model with binomial distribution and logit link. Residual plots of the fitted model were used to verify model assumptions and to detect outliers. Least square means of the disease incidences of the tested varieties were compared with the standard Co 775.

RESULTS AND DISCUSSION

Ariyawansha (2014) has classified Co 775 as a generally-adaptable sugarcane variety with average cane and sugar yields and SL 83 06 as a generally-adaptable, high- cane and - sugar yielding variety. Therefore, these two varieties were used as the standards for comparing cane and sugar yields and their components of the varieties tested.

Table 1. The sugarcane varieties tested in the experiment

No.	Variety	Country of origin	No.	Variety	Country of origin
Recommended imported varieties			*Locally-bred near-commercial varieties*		
1	F 148	Taiwan	25	SL 89 309	Sri Lanka
2	M 438 59	Mauritius	26	SL 89 2227	Sri Lanka
3	Co 775	India	27	SL 93 697	Sri Lanka
Recommended locally–bred varieties			28	SL 93 938	Sri Lanka
4	SL 71 03	Sri Lanka	29	SL 93 945	Sri Lanka
5	SL 71 30	Sri Lanka	30	SL 94 3325	Sri Lanka
6	SL 83 06	Sri Lanka	31	SL 95 4225	Sri Lanka
7	SL 86 13	Sri Lanka	32	SL 95 4226	Sri Lanka
8	SL 88 116	Sri Lanka	33	SL 95 4421	Sri Lanka
9	SL 89 1673	Sri Lanka	34	SL 96 061	Sri Lanka
10	SL 90 6237	Sri Lanka	35	SL 96 175	Sri Lanka
11	SL 92 4918	Sri Lanka	36	SL 96 347	Sri Lanka
12	SL 92 4997	Sri Lanka	37	SL 96 771	Sri Lanka
13	SL 92 5588	Sri Lanka	38	SL 97 1118	Sri Lanka
14	SL 95 4430	Sri Lanka	39	SL 97 1239	Sri Lanka
15	SL 95 4033	Sri Lanka	40	SL 97 1447	Sri Lanka
16	SL 95 4443	Sri Lanka	41	SL 97 1466	Sri Lanka
17	SL 96 128	Sri Lanka	42	SL 98 2001	Sri Lanka
18	SL 96 328	Sri Lanka	43	SL 98 2118	Sri Lanka
19	SL 98 2524	Sri Lanka	44	SL 98 2535	Sri Lanka
Locally-collected varieties			45	SL 98 2549	Sri Lanka
20	SLC 2009 1	Sri Lanka	46	SL 99 3035	Sri Lanka
21	SLC 2009 2	Sri Lanka	47	SL 99 3301	Sri Lanka
Tissue cultured sub-clones			48	SL 99 3384	Sri Lanka
22	SLT 4920	Sri Lanka	49	SL 99 3556	Sri Lanka
23	SLT 4921	Sri Lanka	50	SL 99 4042	Sri Lanka
24	SLT 88 238*	Sri Lanka			

Note: *Tissue culture sub-clone of variety M 337 56 recommended for cultivation under rain-fed conditions (*Source*: Recommended crop varieties of Sri Lanka - 2006, SL-CARP)

Comparison of cane and sugar yields and their components with Co 775

The means of number of millable canes per plot, stalk length, stalk diameter, number of internodes per stalk, plot cane yield, cane yield per hectare, rind hardness and fibre percent are given in Table 2. The means of brix, pol, purity, pure obtainable cane sugar (POCS) and sugar yields of the tested varieties are given in Table 3.

Wijesuriya (2012) has reported that stalk length and number of stalks are the major determinants of cane yield. In this experiment, significant differences between stalk lengths of tested varieties were not observed. However, significantly-higher number of millable canes per plot (86 to 106) were observed in the varieties SL 86 13, SL 90 6237, SL 97 1466, SL 99 3301 and M 438 59. Stalk diameters of the varieties SL 92 5588, SL 93 945, SL 96 061, SL 96 175, SL 96 771, SL 99 3301 and M 438 59 were significantly-lower than the standard Co 775. The variety Co 775 had 18 numbers of internodes per stalk and all the varieties have shown non-significant number of internodes except for significantly-higher number of internodes per stalk in the varieties SL 95 4033 and SL 99 3384.

Significantly-higher cane yields per plot were observed in the varieties SL 98 2524 (92.2 kg), SL 96 128 (82.5 kg), SL 99 3301 (82.2 kg), SL 98 2549 (82 kg) and SL 98 2118 (81.7 kg), compared to Co 775 (41.5 kg). It is interested to note that SL 96 128 and SL 98 2524 which were recently-introduced new-improved varieties were among the high-cane-yielding varieties. The highest plot cane yield (92.2 kg) was observed in the variety SL 98 2524 and the second highest was observed in SL 96 128 (82.5 kg). Cane yields per hectare were calculated using plot cane yields and therefore, plot cane yields and cane yields per hectare followed the similar pattern. Cane yields (mt/ha) of the varieties SL 96 128, SL 98 2118, SL 98 2524, SL 98 2549 and SL 99 3301 were significantly-higher than Co 775 and the highest cane yield (154 mt/ha) was recorded in SL 98 2524. The second highest cane yield (138 mt/ha) was recorded in the variety SL 96 128 which is currently-occupying the highest proportion (58%) of the commercial sugarcane plantations in Sri Lanka. The varieties SL 98 2118, SL 98 2549 and SL 99 3301 have not yet been recommended and released for commercial cultivation, since they are still under evaluation for reactions of diseases.

Wijesuriya *et al*. (1993) observed significant correlations between rind hardness and fibre percent and suggested that rind hardness can be used to approximate fibre percent in cane. Higher rind hardness makes difficulty in manual cane harvesting. However, in this experiment, non-significant rind hardness values were observed between varieties. Similarly, the fibre percent also was not significantly-different in the varieties tested. Wijesuriya *et al*. (1993) reported that the required range of fibre in commercial canes for sugar manufacturing is 11-15% and it is observed that all the varieties tested in this experiment are within this range.

Wijesuriya *et al*. (1993) further reported that pure obtainable cane sugar (POCS) determines sugar yield and brix, pol, and purity had significant positive phenotypic and genetic correlations with POCS. The varieties SLT 88 238, SL 98 2524 and M 438 59 had significantly-low brix values (15.37-16.60) and significantly-low pol values in the varieties SLT 88 238, SL 89 1673 and M 438 59 (12.27-13.18) compared to Co 775. It is observed that the purity of variety Co 775 was 86 % and the varieties SLT 88 238, SL

89 1673 and SL 98 2535 had significantly-low purity compared to Co 775, indicating late maturing nature of these three varieties. All the other varieties had non-significant purity values compared to Co 775. All the varieties showed non-significant POCS except for the varieties SLT 88 238, SL 89 1673 and M 438 59 which showed significantly-low values. The highest sugar yield (19 mt/ha) was observed in the variety SL 96 128 and the second highest was (17 mt/ha) in SL 99 3301. Sugar yield of these two varieties were significantly-higher than Co 775 and the other varieties tested were not significantly-different to Co 775. Therefore, all the varieties tested in this experiment can be considered for commercial cultivation.

Comparison of cane and sugar yields and their components with SL 83 06

Mean stalk length of SL 83 06 was 198 cm and significantly-low stalk lengths were observed in the varieties SL 96 328, SL 96 771, F 148 and SLT 4920 compared to SL 83 06. The varieties SL 90 6237 and SL 99 3301 had significantly-higher number of millable canes (106 and 105, respectively) while SL 83 06 having 63 number of millable canes. Stalk diameter of SL 83 06 was 28 mm and significantly-low stalk diameter was observed in varieties SL 99 3301 and M 438 59 (22 mm). It was observed that SL 92 4997 and F 148 had significantly-higher stalk diameter (32 mm) compared to SL 83 06. The variety SL 83 06 recorded 23 numbers of internodes and the numbers of internodes recorded in all the varieties were not significantly-different except for SL 71 03, SL 96 771 and F 148 which had significantly-lower values. Plot cane weight, cane yield per hectare, rind hardness and fibre were not significantly-different in the tested varieties compared to SL 83 06.

The varieties SLT 88 238, SL 98 2524 and M 438 59 had significantly-lower brix compared to SL 83 06. Significantly-low pol percentages were observed in the varieties SLT 88 238, SL 89 1673, SL 98 2524 and M 438 59 compared to the same standard. Mean purity of SL 83 06 was 87 % and significantly-lower purity values were observed in the varieties SL 88 238, SL 89 1673 and SL 98 2535. POCS in all the varieties tested were not significantly-different to SL 83 06 (13.1 %) except for the varieties SLT 88 238, SL 89 1673, SL 97 1447, SL 98 2524, SL 98 2535 and M 438 59, which showed significantly-lower values. Sugar yields of the varieties tested were not significantly-different to sugar yield of SL 83 06 though some of the sugar yield components showed significant differences to the standard.

Table 2. Cane yield components, plot cane weight, rind hardness and fibre percentage of tested varieties

Variety	Stalk diameter (mm)	Stalk lengths (cm)	Number of internodes	NMC	Plot weight (kg)	Rind hardness (mm)	Fibre (%)
SL 98 2524	31.7	196	19	76	92.2*	30.6	13.4
SL 96 128	27.6	212	24	64	82.5*	29.5	13.1
SL 99 3301	21.9*+	197	21	105*+	82.2*	29.4	14.8
SL 98 2549	29.6	193	19	68	82.0*	28.0	14.0
SL 98 2118	27.2	203	22	83	81.7*	25.2	12.4
SL 95 4225	26.9	179	22	78	76.0	25.8	11.9

Variety	Stalk diameter (mm)	Stalk lengths (cm)	Number of internodes	NMC	Plot weight (kg)	Rind hardness (mm)	Fibre (%)
SL 98 2001	27.3	205	20	62	75.3	28.7	12.0
SL 86 13	25.4	176	21	86*	73.5	26.9	13.0
SL 97 1466	25.9	176	18	91*	69.7	23.3	12.1
SL 95 4421	29.6	201	20	66	68.8	25.6	13.0
SL 71 03	29.2	179	16+	67	65.2	26.9	12.1
SL 92 4918	30.8	182	21	62	65.0	25.5	13.2
SL 97 1447	30.6	167	19	59	65.0	29.6	12.5
SL 94 3325	28.5	197	20	55	64.5	24.4	10.9
SL 98 2535	28.7	192	22	70	63.5	19.5	12.4
SL 93 938	25.7	191	20	69	63.3	23.7	12.6
SLT 88 238	27.9	188	19	75	62.7	23.4	11.0
SL 95 4443	28.3	155	19	65	62.3	28.0	10.9
SL 95 4033	27.5	214	25*	62	61.0	23.3	13.7
SL 83 06	**27.9**	**198**	**23**	**63**	**59.3**	**21.7**	**12.3**
SL 95 4430	27.4	174	21	65	58.8	24.5	12.7
SL 88 116	29.5	164	21	56	57.2	28.5	12.9
SL 92 5588	25.2*	166	21	78	56.5	28.3	12.7
SL 96 061	24.6*	188	17	80	56.2	25.3	11.7
SL 90 6237	25.4	165	18	106*+	54.8	25.7	12.7
M 438 59	22.0*+	190	20	89*	54.7	25.2	13.2
SL 97 1239	26.9	206	21	45	54.5	27.0	13.2
SL 99 3556	27.7	182	22	61	54.3	20.4	11.1
SL 89 2227	27.0	187	21	64	54.0	21.2	13.3
SL 96 175	24.0*	178	19	75	53.8	25.8	11.7
SL 99 4042	26.7	179	22	61	52.2	23.2	11.3
SL 99 3035	26.3	182	22	58	49.2	21.5	13.1
SL 99 3384	27.0	196	25*	45	48.0	24.9	11.9
SL 96 347	26.2	148	21	69	47.7	22.9	11.7
SL 97 1118	27.3	191	22	43	46.0	26.9	12.5
SL 92 4997	32.0+	151	18	47	45.8	23.4	12.4
SL 96 328	27.8	133+	19	64	45.0	28.5	13.2
SL 93 697	25.8	155	17	65	43.7	23.1	11.3
SLT 4921	29.4	150	19	50	42.7	25.1	12.2
SLT 4920	29.5	133+	20	50	42.7	24.4	11.0
SL 89 309	26.2	168	19	52	42.5	22.2	12.2
SL 95 4226	26.7	190	21	48	41.7	26.5	11.6
Co 775	**29.2**	**163**	**18**	**51**	**41.5**	**22.7**	**12.9**
SLC 2009 1	29.5	143	17	52	40.8	23.4	11.2
SLC 2009 2	27.2	171	18	42	40.0	26.3	11.9
SL 89 1673	27.5	158	19	49	39.8	20.8	11.7
SL 93 945	24.6*	166	19	56	39.5	25.2	13-0
SL 96 771	24.3*	125+	13+	75	37.3	23.9	10.8
SL 71 30	28.5	165	20	45	36.0	25.0	11.8
F 148	32.2+	130+	16+	50	33.0	21.5	11.5

Note: Means with symbols * and + are significantly-different at P < 0.05 compared to Co 775 and SL 8306, respectively. The values in bold face are respective to standard varieties Co 775 and SL 83 06

Table 3. Sugar yield, cane yield, brix, pol, purity and POCS of tested varieties

Variety	Sugar yield (mt/ha)	Cane yield (mt/ha)	Brix (%)	Pol (%)	Purity (%)	POCS (%)
SL 96 128	19.0*	137.5*	20.0	17.8	88.8	13.4
SL 99 3301	17.7*	136.9*	19.5	17.5	89.4	13.0
SL 98 2118	16.8	136.2*	18.5	16.3	87.8	12.3
SL 95 4225	16.3	126.7	19.6	17.1	87.4	13.0
SL 86 13	16.3	122.5	19.4	17.3	89.5	13.2
SL 98 2524	15.2	153.6*	16.4*+	13.6+	83.0	9.8+
SL 98 2549	15.1	136.7*	18.0	15.3	85.1	11.2
SL 98 2001	15.0	125.6	17.8	15.7	88.1	11.9
SL 97 1466	14.9	116.1	19.7	17.0	86.0	12.7
SL 93 938	14.8	105.6	20.3	18.2	89.8	14.0
SL 95 4421	14.0	114.7	19.3	16.5	85.5	12.2
SL 95 4443	13.6	103.9	19.1	16.9	88.2	13.1
SL 92 4918	13.1	108.3	20.0	16.8	83.9	12.2
SL 83 06	**13.1**	**98.9**	**20.0**	**17.4**	**87.0**	**13.1**
SL 88 116	13.0	95.3	20.4	18.0	88.2	13.6
SL 94 3325	13.0	107.5	18.1	15.6	86.1	11.9
SL 95 4033	12.7	101.7	20.1	17.2	85.7	12.6
SL 92 5588	12.6	94.2	19.4	17.5	90.1	13.4
SL 96 175	12.3	89.7	20.3	17.9	88.2	13.7
SL 71 03	12.2	108.6	18.4	15.1	81.9	10.9
SL 89 2227	12.0	90.0	21.0	18.1	86.1	13.4
SL 95 4430	12.0	98.0	18.6	16.1	86.7	12.1
SL 99 4042	11.8	86.9	19.2	17.2	89.4	13.4
SL 97 1239	11.6	90.8	19.3	17.1	88.3	12.9
SL 96 061	10.7	93.6	18.5	15.7	84.2	11.7
SL 99 3035	10.6	81.9	20.1	17.5	86.7	13.0
SL 99 3384	10.6	80.0	19.6	17.3	88.6	13.3
SL 98 2535	10.5	105.8	18.4	14.4	78.0*+	10.1+
SL 97 1447	10.5	108.3	17.6	13.9	79.1	9.8+
SL 99 3556	10.4	90.6	18.2	15.4	84.5	11.6
SL 92 4997	10.3	76.4	20.5	17.9	87.1	13.5
SL 96 347	10.0	79.4	19.3	16.7	86.6	12.7
SL 90 6237	9.6	91.4	18.0	14.7	81.5	10.6
SLT 4921	9.5	70.3	20.6	17.8	86.3	13.4
SL 96 328	9.5	75.0	20.0	17.1	85.5	12.6
SLT 4920	9.3	70.3	20.1	17.5	87.0	13.4
SL 95 4226	9.2	69.4	19.6	17.2	87.7	13.1
SLC 2009 2	9.2	66.7	20.7	18.1	87.3	13.7
SL 97 1118	9.0	76.7	18.9	16.0	84.4	11.8
SLC 2009 1	9.0	68.1	19.9	17.2	86.5	13.1
Co 775	**8.8**	**69.2**	**19.9**	**17.1**	**86.1**	**12.7**
SLT 88 238	8.8	104.4	16.6*+	12.3*+	73.9*+	8.3*+
M 438 59	8.5	91.1	15.4*+	12.8*+	83.8	9.3*+
SL 89 309	8.4	70.8	19.3	16.1	83.4	11.8
SL 93 697	8.2	71.9	18.3	15.6	84.9	11.7
SL 93 945	8.0	65.8	19.1	16.3	85.3	12.0
SL 71 30	7.7	60.0	19.6	16.9	86.5	12.8
F 148	7.1	55.0	20.0	17.2	85.8	13.0
SL 96 771	6.8	62.2	16.9	14.1	83.1	10.5
SL 89 1673	6.4	66.4	17.3	13.2*+	76.3*+	9.1*+

Note: Means with the symbols * and + are significantly-different at $P < 0.05$ compared to Co 775 and SL 83 06, respectively. The values in bold face are respective to standard varieties Co 775 and SL 83 06

WLD incidences and assessment of varietal performances

Although, the trial was conducted in WLD-prone environment, WLD incidences were observed to be very low (0.0 – 6.0%) in the plant crop (Table 4). This agrees with the findings of Taweekul *et al*. (2012) who observed low disease incidences in plant crop in the areas with high WLD infection. In general, sugarcane WLD does not appear vigorously in plant crops unless seed materials are severely-infected with the diseases. Wongkaew (2012) explained that the comparatively-high vigour of plant crops than the ratoon crops is the main reason for low incidences of WLD in plant crops.

A noticeable increase of WLD symptoms was observed in the ratoon crop (Table 5). Therefore, disease incidences were analysed by assuming binomial distribution. Binomial model achieved convergence within five iterations. The residual plots are used to verify whether the data meet the assumptions of the fitted model and to detect outliers. Data points of the residual plot are falling within the ±2 limits except few data points which are commonly-used as a rule of thumb for outlier detection. The studentized conditional residual plots followed standard normal distribution.

Table 4. Varieties with white leaf disease (WLD) symptoms, their incidences (%) and number of WLD vectors collected from 1000 net-sweeps at 3, 4, 5 and 6 months after planting in the plant crop

Variety[1]	**WLD incidences (%)**[2]			
	At 3 months	**At 4 months**	**At 5 months**	**At 6 months**
SL 83 06	-	-	3.1	-
SL 96 771	-	3.6	5.6	5.8
SL 97 1447	-	-	3.1	6.2
SL 98 2001	4	4.1	3.4	5.9
SL 98 2118	-	-	-	2.0
SL 98 2535	-	-	1.8	-
SLI 121	-	2.2	1.9	-
Vectors[3]	4	7	41	39

[1]Varieties with WLD symptoms in plant crop
[2]Average WLD incidence of three replicates
[3]Number of vectors per 1000 net-sweeps in the field

Presence of WLD vector was observed in plant crop of this experimental field (Table 4), which was favourable for spread of this disease. It was noted that the WLD incidence in Co 775 was 47.6% in two-month-aged ratoon crop and non-significant WLD incidences compared to Co 775 were observed in several other varieties including SL 71 03, SL 71 30, SL 88 116, SLT 88 238, SL 89 1673, SL 90 6237, SL 92 4918, SL 92 4997, SL 95 4033, SL 95 4443, SL 96 128, SL 98 2524 and F 148, which have already been recommended and released for commercial cultivation. Since, the experiment was conducted under a WLD-infected environment, high WLD incidences were observed in most of the varieties as reported by Taweekul *et al*. (2012). However, some of those varieties; SLT 88 238, SL 90 6237, SL 95 4033, SL 95 4443 and SL 97 1118 have shown significantly-lower WLD incidences when the crop reached four months in age and it may be due to the masking of symptoms as reported by the Matsumoto *et al.* (1969) and Senevirathne (2008).

Ariyawansha (2012) reported that variety SLT 88 238 is a generally-adaptable variety in terms of both cane and sugar yields but susceptible to sugarcane WLD. Though, the recommended varieties SL 83 06, SL 95 4430 and the non-recommended variety SL 99 3035 showed significantly-lower incidence of WLD (22%, 8% and 25%, respectively) in two month-aged ratoon crop, the incidences have increased to 35%, 35% and 48%, respectively, when the crop reached four months. The variety SL 71 03 showed better performances in terms of cane and sugar yields as observed by De Silva (2007). However, variety SL 71 03 should not be promoted in WLD prone environments since it has recorded significantly higher WLD incidence (81%) in the ratoon crop at four months.

WLD incidences in the above-mentioned new-improved sugarcane varieties emphasized that limitation in growing those varieties in WLD-prone environments because there is an epidemic situation of WLD in local commercial sugarcane plantations (Rathnayake *et al.,* 2013). Keerthipala (2016) reported that adoption of sugarcane crop management practices including pest and diseases management are not at satisfactory level in the local sugarcane plantations. Therefore, the results of this experiment clearly highlighted that the need of adopting proper sugarcane crop management practices not only for receiving better income but also for sustainability of the local sugarcane industry.

The varieties SL 96 061 and SL 96 175 showed significantly-higher WLD incidences (83.4% and 76.1%, respectively) even in two-month-old ratoon crop. Therefore, these two varieties cannot be recommended for commercial cultivation in WLD-prone conditions.

It is very clearly indicated that the varieties SL 86 13, SL 89 309, SL 89 2227, SL 92 5588, SL 95 4225, SL 95 4226, SL 95 4421, SL 96 328, SL 96 347, SL 97 1239, SL 98 2001, SL 98 2118, SL 99 3384, SL 99 4042 and M 438 59 have significantly-low incidences of WLD in two-month-aged ratoon crop and were significantly-low even at four months. The varieties SL 92 5588 and SL 95 4225 showed almost similar incidences of WLD (15%) when ratoon crop reached four months. The variety SL 89 309 had disease level below 10% and varieties SL 86 13 and SL 99 3384 showed disease level below 5% when ratoon crop reached four months (Table 5). SL 86 13 is among the recommended varieties and SL 99 3384 has not yet been recommended for commercial cultivation. The results of this experiment revealed that the importance of these two varieties as strategic crops to cultivate in WLD-prone environments and can be used as parents in breeding for WLD resistance.

Table 5. Percentage of WLD incidences in tested varieties in ratoon crop

Variety	WLD incidence (%)		Variety	WLD incidence (%)	
	At 2 months	At 4 months		At 2 months	At 4 months
SL 86 13	2.22*	4.98*	SL 71 03	41.67	80.72*
SL 99 3384	2.38*	1.96*	SLI 121	41.82	50.78
SL 89 309	2.38*	8.91*	SL 98 2535	42.82	36.35
SL 92 5588	4.18*	15.18*	SL 95 4443	43.17	26.11*
SL 95 4225	5.92*	15.46*	SL 97 1447	45.60	46.75
SL 99 4042	7.69*	20.21*	SL 71 30	46.53	56.84
SL 95 4430	7.84*	35.29	SL 89 1673	47.05	51.17
SL 96 328	10.90*	16.67*	SLC 2009 1	47.44	37.95
SL 89 2227	14.17*	25.16*	SL 99 3556	50.22	52.07
SL 98 2001	21.15*	13.40*	SLT 88 238	51.27	24.36*
SL 83 06	22.34*	34.86	SL 92 4918	54.44	41.87
SL 95 4226	22.72*	16.40*	SL 94 3325	54.86	35.24
SL 98 2118	22.88*	24.31*	SL 93 697	56.25	60.70
M 438 59	24.43*	25.00*	SL 88 116	56.69	40.72
SL 99 3035	25.18*	48.06	SL 93 945	57.58	21.64*
SL 95 4421	26.38*	24.21*	SL 98 2524	60.85	57.26
SL 97 1239	27.29*	20.35*	SLC 2009 2	61.11	45.15
SL 96 347	27.55*	20.64*	SL 90 6237	64.29	25.15*
SL 92 4997	31.75	35.45	SL 96 771	66.52	45.59
SL 96 128	33.73	27.97	SL 99 3301	67.36	48.65
SL 93 938	34.25	13.76*	SL 98 2549	73.81	48.76
SLT 4920	34.57	36.70	SL 96 175	76.14*	50.22
SLT 4921	36.49	32.14	SL 97 1466	78.52	49.35
SL 97 1118	39.38	22.72*	SL 96 061	83.40*	37.15
SL 95 4033	40.76	19.77*	**Co 775**	**47.61**	**37.03**

Note: * Means with significant difference ($P < 0.05$) compared to the mean of Co 775, Figures in bold face are values relevant to Co 775

CONCLUSIONS AND SUGGESTIONS

It is found that none of the variety in "Sugarcane Breeder's Seed Stock" can resist sugarcane white leaf disease (WLD), completely. The varieties SL 86 13 and SL 99 3384 have shown better tolerance to WLD and hence they can be grown as strategic varieties in WLD-prone areas in commercial plantations. Moreover, the varieties SL 89 309, SL 92 5588 and SL 95 4225 are also identified as suitable varieties for planting in the areas with high WLD incidences. The recommended variety SL 71 03 is found not suitable for growing in WLD-prone environments. Varieties SL 96 175 and SL 96 061 have been found as most susceptible to WLD. High emergence of WLD in ratoon crops suggested that adoption of proper crop management practices recommended by the Sugarcane Research Institute is needed in minimizing crop losses of the new-improved varieties due to the disease. The findings will benefit sugar industries and farmers in selecting the varieties for WLD-prone areas and sugarcane breeders in selecting parents in directional crosses for development of WLD-resistant sugarcane varieties. Further evaluation of WLD reactions of the varieties which have not yet been released for commercial cultivation is recommended.

Future studies

Evaluation of the effect of WLD on plant and ratoon crop yields of the tested varieties is suggested in a replicated experiment with large plot sizes.

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